THURSDAY, FEBRUARY 9, 1882

PROFESSOR HUXLEY'S ESSAYS

Science and Culture, and other Essays. By Thomas Henry Huxley, LL.D., F.R.S. (London: Macmillan and Co., 1881.)

THIS collection of Prof. Huxley's more recent lectures and essays appears as a companion volume to the previous well-known collections of the same kind. The first thing, therefore, that naturally occurs to us is to compare this series with its predecessors, for when an author has been so long and so prominently before the public as Prof. Huxley, and when the authorship has been of a kind so varied and original, we cannot but entertain fears, even for the strongest man, that signs of exhaustion may become apparent in the works of his middle life. But if any one should entertain such charitable apprehensions on behalf of Prof. Huxley they may immediately be quieted by the book before us; the eye is as clear for seeing and the arm as strong for hitting as they have always been, and on every page we meet with new instances of that same versatility of learning, force of thought, and brilliancy of style which, while producing so wide an influence on the science and philosophy of our time, have justly placed this distinguished leader of both in a class *sui generis* as an expositor.

The first essay, as the title of the collection signifies, is that on Science and Culture.

"From the time that the first suggestion to introduce physical science into ordinary education was timidly whispered, until now, the advocates of scientific education have met with opposition of two kinds. On the one hand they have been pooh-poohed by the men of business who pride themselves on being the representatives of practicability, while on the other hand they have been excommunicated by the classical scholars, in their capacity of Levites in charge of the ark of culture and monopolists of liberal education."

The first of these two classes of opponents is easily disposed of, notwithstanding that "your typical practical man has an unexpected resemblance to one of Milton's angels; his spiritual wounds, such as are inflicted by logical weapons, may be as deep as a well and as wide as a church door, but beyond shedding a few drops of ichor, celestial or otherwise, he is no whit the worse." But the other class of opponents is more formidable, and as the essay is "an Address delivered at the opening of Sir Josiah Mason's Science College at Birmingham," Prof. Huxley observes—

"It is not impossible that we shall hear the express exclusion of 'literary instruction and education' from a College which, nevertheless, professes to give a high and efficient education, sharply criticised. Certainly the time was that the Levites of culture would have sounded their trumpets against its walls as against an educational Jericho."

The address therefore proceeds to justify the action of the founder in having imposed this exclusion.

"For," says Prof. Huxley, "I hold very strongly by two convictions. The first is, that neither the discipline nor the subject-matter of classical education is of such direct value to the student of physical science as to justify the expenditure of valuable time on either; and the second is, that for the purpose of attaining real culture, an exclusively scientific education is at least as effectual as an exclusively literary education."

The remainder of the essay proceeds to make good these two propositions, and in the course of doing so gives an interesting historical sketch of the circumstances which have hitherto led to an undue depreciation of the study of science as an instrument of mental culture. In the Middle Ages, and so long as theological dicta held exclusive sway, men "were told how the world began and how it would end; they learned that all material existence was but a base and insignificant blot upon the fair face of the spiritual world, and that nature was, to all intents and purposes, the playground of the devil." Although this statement of the case is, as it is no doubt intended to be, hyperbolical rather than historical, there can be no question that it "was far from the thoughts of men trained" in the system of mediæval theology to suppose "that the study of nature—further than was requisite for the satisfaction of everyday wants—should have any bearing on human life." But—

"The distinctive character of our own times lies in the vast and constantly increasing part which is played by natural knowledge. Not only is our daily life shaped by it, not only does the prosperity of millions of men depend upon it, but our whole theory of life has long been influenced, consciously or unconsciously, by the general conceptions of the universe which have been forced upon us by physical science."

Therefore it is obvious that we must now hold a different estimate of the importance of physical science in relation to culture, if with Mr. Matthew Arnold we mean by culture "the knowledge of the best that has been thought and said in the world."

"The period of the Renascence is commonly called that of the 'Revival of Letters,' as if the influence then brought to bear upon the mind of Western Europe had been wholly exhausted in the field of literature. I think it is very commonly forgotten that the revival of science, affected by the same agency, although less conspicuous, was not less momentous. . . . . We falsely pretend to be inheritors of their culture [*i.e.* that of the Greeks], unless we are penetrated, as the best minds among them were, with an unhesitating faith that the free employment of reason, in accordance with scientific method, is the sole method of reaching truth."

The address continues:—

"But I should be very sorry that anything I said should be taken to imply a desire on my part to depreciate the value of classical education, as it might be and as it sometimes is. The native capacities of mankind vary no less than their opportunities, and while culture is one, the road by which one man may best reach it is widely different from that which is most advantageous to another. . . . But for those who mean to make science their serious occupation, or who intend to follow the profession of medicine, or who have to enter early upon the business of life, for all these, classical education is in my opinion a mistake; and it is for this reason that I am glad to see 'mere literary education and instruction' shut out from the curriculum of Sir Josiah Mason's College, seeing that its inclusion would probably lead to the introduction of the ordinary smattering of Latin and Greek."

The second essay, which is "the Inaugural Address of the Lord Rector of the University of Aberdeen," is entitled "Universities, Actual and Ideal." Here the leading theme is that an "ideal university" should be open to men of all classes, and be able efficiently to teach all branches of knowledge. "I should like to see Professors of the Fine Arts in every University; and instruction in some part of their work make a part of the Arts curriculum." "If there are Doctors of Music, why should there be no Masters of Painting, of Sculpture, of Architecture?" This is one kind of knowledge; another is "knowledge relating to the scope and limits of the mental faculties of man; a form of knowledge which, in its positive aspect, answers pretty much to Logic, and part of Psychology, while, on its negative and critical side it corresponds with Metaphysics." Yet another class "comprehends all that knowledge which relates to man's welfare, so far as it is determined by his own acts, or what we call his conduct. It answers to Moral and Religious Philosophy." Lastly, there is "knowledge of the phenomena of the universe," or science, mathematical, physical, biological, and social. Concerning the relative importance of these departments of knowledge, substantially the same opinion is expressed as in the previous address: "I am ashamed to repeat here what I have said elsewhere, in season and out of season, respecting the value of science as knowledge and discipline," &c. Concerning the teaching of science, it is shown that the "ideal University" "ought not to be satisfied with mere book-knowledge. . . . If I may paraphrase Hobbes' well-known aphorism, I would say that 'books are the money of literature, but only the counters of science.'" The address next goes on to the question of Medical Education, advocating the abolition of Botany, Zoology, and Comparative Anatomy from the curriculum. Speaking of the study of Physiology, the Lord Rector says—

"Moreover, I would urge that a thorough study of Human Physiology is in itself an education broader and more comprehensive than much that passes under that name. There is no side of the intellect which it does not call into play, no region of human knowledge into which either its roots or its branches do not extend; like the Atlantic between the Old and the New Worlds, its waves mark the shores of the two worlds of matter and of mind; its tributary streams flow from both; through its waters, as yet unfurrowed by the keel of any Columbus, lies the road, if any such there be, from the one to the other; far away from that North-West Passage of mere speculation, in which so many brave souls have been hopelessly frozen up."

In an ideal University it should be recognised that Science has the same right as Theology, Law, or Medicine to a

"Faculty of its own in which men shall be trained to be professional men of science . . . The establishment of such a Faculty would have the additional advantage of providing, in some measure, for one of the greatest wants of our time and country; I mean proper support and endowment of original research. . . . If a student of my own subject shows power and originality, I dare not advise him to adopt a scientific career . . . and I believe the case is as bad, or perhaps worse, with other branches of science. In this respect Britain, whose immense wealth and prosperity hangs on the thread of applied science, is far behind France, and infinitely behind Germany."

On the subject of Examinations Prof. Huxley says:—

"Examination, like fire, is a good servant, but a bad master; and there seems to me to be some danger of its becoming our master. I by no means stand alone in this opinion. Experienced friends of mine do not hesitate to say that students whose career they watch, appear to them to become deteriorated by the constant effort to pass this or that examination, just as we hear of men's brains becoming affected by the daily necessity of catching a train. They work to pass, not to know; and outraged science takes her revenge. They do pass, and they don't know. . . . Under the best of circumstances, I believe that examination will remain but an imperfect test of knowledge, and a still more imperfect test of capacity, while it tells next to nothing about a man's power as an investigator."

While dealing with the desirability of undergraduates having had sufficient instruction at school to profit by the higher education which ought to be provided by a university, Prof. Huxley says:—

"A high authority, himself head of an English college, has solemnly affirmed that: 'Elementary teaching of youths under twenty is now the only function performed by the University'; and that colleges are 'boarding schools in which the elements of the learned languages are taught to youth.' This is not the first time I have quoted these remarkable assertions. I should like to engrave them in public view, for they have not been refuted."

Here we are less surprised at the certainly "remarkable assertions" of the Rector of Lincoln, than by their unqualified endorsement of the Rector of Aberdeen; for if "they have not been refuted" we should suppose that the only reason must be because they are too obviously extravagant to demand refutation. That our English universities have thrown upon them a great deal more work in the way of comparatively elementary education than is either desirable or creditable, and that in consequence a vast amount of money and of teaching power is misappropriately applied, no one can dispute; but to "solemnly affirm" that the *only* function of these universities is that of boarding schools, is unwisely to overstate the evil.

The third essay is on "Technical Education." Delivered before the "Working Men's Club and Institute," it appropriately inculcates—

"The truth that while under-instruction is a bad thing, over-instruction may possibly be a worse. Success in any kind of practical life is not dependent solely, or even chiefly, upon knowledge. Even in the learned professions, knowledge, alone, is of less consequence than people are apt to imagine. And, if much expenditure of bodily energy is involved in the day's work, mere knowledge is of still less importance when weighed against the probable cost of its acquirement."

The ideal of "Technical education for handicraftsmen" held out by Prof. Huxley is that of avoiding excess either of general or of technical instruction for "the great mass of mankind who have neither the liking nor the aptitude for either literary, or scientific, or artistic pursuits," while making provision "to catch exceptional people—the small percentage of the population which is born with that most excellent quality, a desire for excellence, or with special aptitudes of one sort or other. . . . I weigh my words when I say that if the nation could purchase a potential Watt, or Davy, or Faraday, at the cost of a hundred thousand pounds down, he would be dirt-cheap at the money."

Substantially the same views are expressed in the next essay, which is on "Elementary Instruction in Physiology." Thus—

> "The saying that a little knowledge is a dangerous thing is, to my mind, a very dangerous adage. If knowledge is real and genuine I do not believe that it is other than a very valuable possession, however infinitesimal its quantity may be. Indeed, if a little knowledge is dangerous, where is the man who has so much as to be out of danger?"

If the life-long labours of the greatest physiologist of his age—William Harvey—had revealed to him a tenth part of the knowledge which may now be made sound and real to our boys and girls "he would have loomed upon the seventeenth century as a sort of intellectual portent."

The address on "Joseph Priestley" is an exceedingly interesting biographical and historical sketch, and is followed by the essay on "The Method of Zadig," which, from having been so recently published in the *Nineteenth Century*, will be fresh in the memory of most readers.

The lecture on "The Border Territory between the Animal and the Vegetable Kingdoms" was delivered at the Royal Institution in January, 1876, and is a masterly piece of biological exposition, which "tends to the conclusion that the difference between animal and plant is one of degree rather than of kind; and that the problem whether, in a given case, an organism is an animal or a plant, may be essentially insoluble."

The essay "On certain Errors respecting the Structure of the Heart attributed to Aristotle," having been originally published in NATURE (vol. xxi. p. 1) need not detain us now; we shall therefore pass on to the next in the series, and the one which has excited more interest and discussion than any of the others. This is the Evening Lecture before the British Association in 1874, "On the Hypothesis that Animals are Conscious Automata;" and both as regards the interest of its subject-matter and the logical precision with which the argument is stated, we think that it deserves to be considered the most important essay in the series.

It is now universally known what the argument is, and how with irrefragable sequence it leads us to the conclusion that—

> "Consciousness would appear to be related to the mechanism of the body simply as a collateral product of its working, and to be as completely without any power of modifying that working as the steam-whistle which accompanies the work of a locomotive engine is without influence upon its machinery."

There can be no doubt that the logic by which this conclusion is reached is everywhere intact; but there is one important criticism to which the "hypothesis" in question is open, and which, as it has not we believe been hitherto clearly advanced, we may briefly state.

The hypothesis rests on the fact that there is a constant parallelism between cerebral processes and mental processes, and as this fact cannot be attributed to accident and is not attributed by the hypothesis of automatism to any pre-established harmony, there remains only the supposition that the true processes are in some way intimately associated. Some intimate association between neurosis and psychosis being thus accepted as a fact by the hypothesis of automatism, the whole question which this hypothesis raises may be briefly put thus:—If the stream of mental activity were withdrawn, could the stream of cerebral activity with which it is now associated continue in exactly the same way, or could it not? In other words, is the constant relation which now subsists between the two processes necessary or unnecessary to the occurrence of the latter? The hypothesis of automatism virtually answers that the relation is unnecessary, and this on the ground of its being inconceivable that it should be necessary. But now let us ask, Is it any more conceivable that this relation should be unnecessary? Certainly not, because the inconceivability resides in the fact of there being *some* relation, and is not affected whether we choose to regard the *character* of this relation as necessary or unnecessary. We may try in thought to refine this relation, and to re-refine it again and again, until we conceive of mental processes as mere indices of corresponding neural processes; but so long as we accept the belief that there is *any one point of contact* between these two sets of processes, so long are we in the presence of just the same difficulty as when we started. Having driven the soul into some minute pineal gland of unnecessary relation, we find after all that we have gained nothing on the side of conceivability; we find it is no more easy to understand the soul as located in this little gland of unnecessary relation, than to understand it as distributed over the whole brainwork of intimate and necessary relation. The hypothesis of automatism would thus appear to contain the elements of its own destruction. For while accepting a fact which renders either the affirmation or the negation of the hypothesis alike inconceivable—viz. the fact of there being *a* connection between neurosis and psychosis—it nevertheless proceeds to choose one of these alternatives in preference to the other; and this on the sole ground of inconceivability.

Of course in advancing this criticism we are not ourselves arguing for any theory. We are merely observing that as in the theory of automatism there is, *ex hypothesi*, *some* connection between neurosis and psychosis which is of a nature not merely unknown but inconceivable, the theory can have no right to affirm, or even to infer, that this connection is unnecessary; and common sense will, therefore, have as much reason as ever to disbelieve that if consciousness had never appeared upon the scene of life, railway trains would now have been running filled with mindless passengers, and telephones would have been invented by brains that could not think, to speak to ears that could not hear. Thus, until it is shown who or what it is that blows the whistle of consciousness in the simile of the steam-engine, we must conclude that the hypothesis of conscious automatism is nothing more than an emphatic re-statement of the truth, that the relation between body and mind is a relation which has so far proved inconceivable.[1]

Essay X. is on "Sensation and the Unity of Structure of Sensiferous Organs." It presents a *résumé* of some of the older theories of sensation, and a clear statement of the modern generalisation that "whatever be the apparent diversities among the sensiferous apparatus, they share certain common characters," &c.

---

[1] It is no answer to say that the *brain* blows this whistle, for even if a causal relation is assumed, it is no more *conceivable* that this should extend from neurosis to psychosis than that it should extend from psychosis to neurosis.

"Evolution in Biology" is an entertaining history of the contest between the theories of Epigenesis and Metamorphosis, passing on to a brief account of the facts relating to the "Evolution of the Individual" as brought to light by modern embryology, and of the "Evolution of the Sum of Living Beings," as previously taught by the older theorists, and as now taught by a conjunction of the sciences.

On the two addresses that remain it is needless to comment, as one of them—viz. that which was delivered before the International Medical Congress in August last—must be well within the recollection of our readers, and the other "On the Coming of Age of the 'Origin of Species,'" has already been printed in these columns (1880). We may, however, fitly conclude our necessarily inadequate review of so much admirable writing by again printing the beautiful peroration of this address.

> "I venture to repeat what I have said before, that, so far as the animal world is concerned, evolution is no longer a speculation, but a statement of historical fact. It takes its place alongside of those accepted truths which must be reckoned with by philosophers of all Schools. Thus when, on the first day of October next, the 'Origin of Species' comes of age, the promise of its youth will be amply fulfilled; and we shall be prepared to congratulate the venerated author of the book, not only that the greatness of his achievement and its enduring influence upon the progress of knowledge have won him a place beside our Harvey; but, still more, that, like Harvey, he has lived long enough to outlast detraction and opposition, and to see the stone that the builders rejected become the head-stone of the corner."

GEORGE J. ROMANES

OUR BOOK SHELF

Proceedings of the London Mathematical Society, vol. xii. (November 11, 1880–November 10, 1881).

THE papers in this volume, as usual, are mostly purely analytical in their character. Prof. Cayley's contributions are very short: the binomial equation $x^p - 1 = 0$; quinquisection; on the flexure and equilibrium of a skew surface; on the geodesic curvature of a curve on a surface, and on the Gaussian theory of surfaces. Sir J. Cockle continues his remarks on binomial biordinals. Mr. Glaisher's papers are also few and short, viz. on some definite integrals expressible in terms of the first complete definite integral, and of gamma-functions; note on certain symbolic operators and their application to the solution of certain partial differential equations. Messrs. Crofton and J. J. Walker have some points of contact, the former writing on operative symbols in the differential calculus, the latter continuing his theorems in the calculus of operations. Mr. Walker also contributes a quaternion proof of a problem discussed by Mr. S. Roberts, viz. certain tetrahedra specially related to four spheres meeting in a point. Mr. Roberts also gives a historical note on Dr. Graves's theorem on confocal conics." Mr. W. R. W. Roberts has a paper on the periods of the first class of hyper-elliptic integrals, and a note on the coordinates of a tangent line to the curve of intersection of two quadrics. Mr. T. Craig has a note on Abel's theorem. Papers bearing on geometry are contributed by Prof. Genese, on a system of co-ordinates; by Mr. H. Hart, on the general equation of the second degree in tetrahedral co-ordinates; by Mr. H. M. Jeffery, on bicircular quartics, with a triple and a double focus, and three single foci, all of them collinear; and on spherical quartics, with a quadruple cyclic arc and a triple focus; by Prof. Mannheim, sur les surfaces parallèles; by Mr. R. A. Roberts, on the tangents drawn from a point to a nodal cubic; and note on a system of cartesian ovals, passing through four points on a circle. Signor Brioschi writes sur une propriété du paramètre de la transformée canonique des formes cubiques ternaires; and Mr. Carpmael renews an old discussion in his some solutions of Kirkman's 15-school-girl problem. The subject of kinematics on a sphere is ably treated by Mr. E. B. Elliott. Mr. Routh contributes some applications of conjugate functions, and Mr. W. D. Niven writes on the electrical capacity of a conductor bounded by two spherical surfaces cutting at any angle. The presidential address is by Mr. C. W. Merrifield, and is entitled "Considerations respecting the Translation of Series of Observations into Continuous Formulæ." We have sketched out a bill of fare appealing to many diverse tastes, and we can assure our readers that the dishes are all of admirable quality.

Jornal de Sciencias Mathematicas e Astronomicas. Publicado pelo Dr. Francisco Gomes Teixeira. (Coimbra, 1881.)

WE have received the first two volumes of this work and the five opening numbers of the third volume. It is a matter of considerable interest to see what a place scientific writings and mathematical works are taking in the Peninsula. The journal before us is apparently not at all ambitious in its aims, but seeks to bring before the students such articles as might perhaps find a place in our own *Messenger of Mathematics.* A fault we have to find with the single numbers is that they have no index of contents, and further, they are unstitched. We wish Prof. Gomes Teixeira every success in his venture.

Philosophische Studien herausgegeben. Von Wilhelm Wundt. Bd. 1 Heft 1. (Leipzig: W. Engelmann, 1881.)

IN the *Philosophische Studien* we have the first instalment of a new periodical conducted by Wilhelm Wundt, which bids fair to attract a wide circle of readers not deterred by close, hard reasoning. It contains four articles:—(1) *On psychological methods*, by the editor; in three sections treating of the psychophysical methods, methods of analysis of the sense-perception, and of psychological measurement of time; (2) *On the length of time in the apperception of simple and compound ideas (colours and numbers)*, by Dr. Max Friedrich; an essay which no doubt owes a great deal also to the editor, and containing the results of some remarkable experiments on the above phenomena; (3) *Investigations on the sense of time*, by Julius Kollert, in continuation of Vierordt's experiments on the same subject; (4) *On mathematical induction*, by the editor, under the heads of "analytical and synthetic methods in mathematics," "the question of the origin of mathematical principles," "experimental beginnings of mathematics," "permanent forms of mathematical induction," "mathematical abstraction," and "exact analogy." The spirit and methods of the editor permeate the whole of this first number, and guarantee the value of the periodical.

Biologische Probleme, zugleich als Versuch einer rationellen Ethik. Von W. H. Rolph. (Leipzig: W. Engelmann, 1881).

ORIGINALLY intended as a criticism on the customary methods of ethics, especially Herbert Spencer's "Data of Ethics," the present work has assumed a wider scope, and embraces the treatment of a number of biological problems, which the author has endeavoured to connect with a view to solution on a common basis. Its aim may be best exhibited in the following enumeration of the subjects discussed:—viz. the doctrine of evolution, subjective systems (Mallock, Spencer, Miss Bevington); H. Spencer's Hedonism; theory of nourishment (hunger the first motive to action, p. 53); theory of development